PSR: Positive Switching Regulators

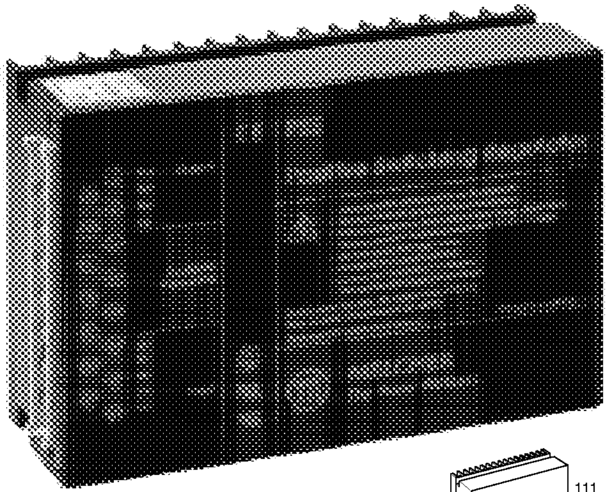
PSS-Family PSK-Family

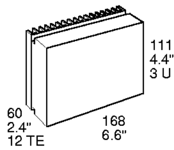
5

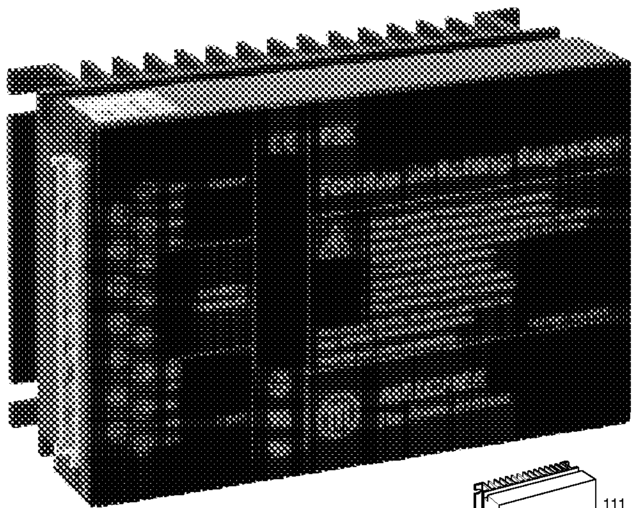
No input to output isolation
Single output of 5.1, 12, 15, 24 or 36 V DC/60...720 W
Input voltage up to 80 V DC

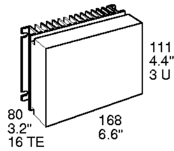
- High efficiency up to 97%
- Wide input voltage range
- Low input to output differential voltage
- Very good dynamic properties
- Input undervoltage lock-out
- Active current sharing for parallel operation
- Output voltage adjustment, inhibit and sense lines
- Fast dynamic response
- Continuous no-load and short-circuit proof
- No derating

Safety according to IEC/EN 60950, UL 1950









Summary

The PSS/PSK family of positive switching regulators is designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input voltages up to 80 V are specially designed for secondary switched and battery driven applications. The standard case design with heat sink allows operation at nominal load up to 71°C without additional cooling, suitable for 19" rack or chassis mounting.

Replacing the heat sink by an optional cooling plate B or B1, allows chassis or wall mounting on top of a metal surface, acting as heat sink.

Connector type according to DIN 41612:
- H15 for output current ≤16 A
- H15 S4 with four high current jacks for output current ≥20 A

Table of Contents

Type Survey and Key Data

Table 1: Type survey

Output voltage $U_{o\,nom}$ [V]	Output current $I_{o\,nom}$ [A]	Input voltage range U_i [V] [1]	Input voltage $U_{i\,nom}$ [V]	Efficiency [2] η_{min} [%]	η_{min} [%]	Type designation	Connector type	Options
5.1	12	8...80	40	78	79	PSS 5A12-7	H15	B, B1 -9 E P C
	16					PSK 5A16-7		
	20					PSK 5A20-7	H15 S4	
	25	8...40	20	82	82	PSK 5A25-7		
12	12	15...80	40	90	91	PSS 1212-7	H15	
	16			89	90	PSK 1216-7		
	20					PSK 1220-7	H15 S4	
15 [3]	12	19...80		90	92	PSS 1212-7	H15	
	16			89	90	PSK 1216-7		
	20					PSK 1220-7	H15 S4	
24	12	29...80	50	93	94	PSS 2412-7	H15	
	16					PSK 2416-7		
	20					PSK 2420-7	H15 S4	
36	12	42...80	60	95	96	PSS 3612-7	H15	
	16			94	95	PSK 3616-7		
	20					PSK 3620-7	H15 S4	

[1] See also *Electrical Input Data:* $\Delta U_{io\,min}$.
[2] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.
[3] Output set to 15 V at R control input

Type Key and Product Marking

Type Key

PSK 12 20 -7 E P C B B1

Positive switching regulator in case S01, K01 ... PSS, PSK
Nominal output voltage in volt (5A for 5.1 V) .... 5A...36
Nominal output current in ampere .... 12...25
Operational ambient temperature range T_A
–25...71 °C .... -7
–40...71 °C (option) .... -9
Options: Inrush current limitation .... E
Potentiometer [1] .... P
Thyristor crowbar C
Cooling plate large .... B
Cooling plate small B1

Example: PSS 1212-7EPCB = A positive switching regulator with a 12 V, 12 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar and large cooling plate B.

Note: All units feature the following auxiliary functions which are not shown in the type designation: Input filter, inhibit, R control, sense lines, current sharing and test jacks.

Produkt Marking

Main face: Family designation, applicable safety approvals and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of auxiliary functions and options, protection degree.

Front plate: Identification of LED, test sockets and optional potentiometer.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

Functional Description

The switching regulators are designed using the buck converter topology. See also *Technical Information: Topologies*. The input is not electrically isolated from the output. During the on period of the switching transistor, current is transferred to the output and energy is stored in the output choke in the form of flux. During the off period, this energy forces the current to continue flowing through the output, to the load and back through the freewheeling diode. Regulation is accomplished by varying the on to off duty ratio of the power switch.

These regulators are ideal for a wide range of applications, where input to output isolation is not necessary, or where already provided by an external front end (e.g. a transformer with rectifier). To optimise customer's needs, additional options and accessories are available.

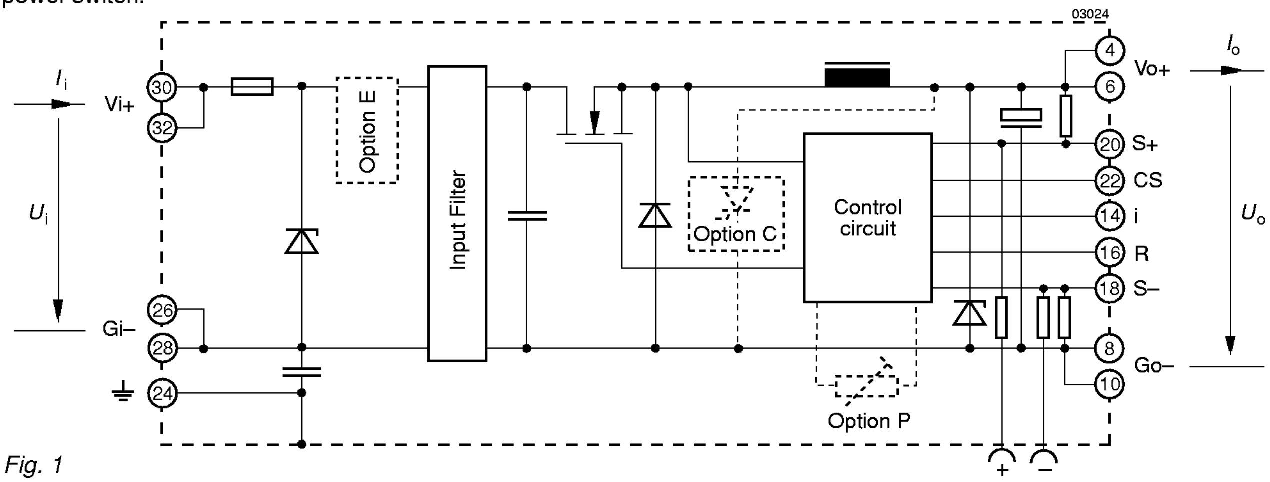


Fig. 1
Block diagram

Electrical Input Data

General Conditions: $T_A = 25\,°C$, unless T_C is specified

Table 2a: Input data

Input			**PSK 5A25**			**PSS 5A12 PSK 5A16 PSK 5A20**			**PSS 1212 PSK 1216 PSK 1220**			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Operating input voltage	$I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	8		40	8		80	15		80	V DC
$\Delta U_{io\,min}$	Min. diff. voltage $U_i - U_o$				2.9			2.9			3	
$U_{i\,o}$	Undervoltage lock-out			6.5			6.5			7.3		
$I_{i\,0}$	No load input current	$I_o = 0$, $U_{i\,min}...U_{i\,max}$			50			50			50	mA
$I_{inr\,p}$	Peak value of inrush current	$U_{i\,nom}$, with option E			20			40			40	A
$u_{i\,RFI}$	Input RFI level, EN 55011/22 0.01...30 MHz	$U_{i\,nom}$, $I_{o\,nom}$			B			B			B	

Table 2b: Input data

Input			**PSS 1212 [1] PSK 1216 PSK 1220**			**PSS 2412 PSK 2416 PSK 2420**			**PSS 3612 PSK 3616 PSK 3620**			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Operating input voltage	$I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	19		80	29		80	42		80	V DC
$\Delta U_{io\,min}$	Min. diff. voltage $U_i - U_o$				4			5			6	
$U_{i\,o}$	Undervoltage lock-out			7.3			12			19		
$I_{i\,0}$	No load input current	$I_o = 0$, $U_{i\,min}...U_{i\,max}$			50			50			50	mA
$I_{inr\,p}$	Peak value of inrush current	$U_{i\,nom}$, with option E			40			50			60	A
$u_{i\,RFI}$	Input RFI level, EN 55011/22 0.01...30 MHz	$U_{i\,nom}$, $I_{o\,nom}$			B			B			B	

[1] Output set to 15 V at R control input, see *Auxiliary Functions.*

Input Filter and Fuse

An input filter and a fuse are incorporated in all modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$u_{i\,max}$ = 10 V_{pp} at 100 Hz, or V_{pp} = 1000 Hz/f_i • 1 V

Inrush Current

Depending on the input source and the input impedance, the inrush current into the regulator may peak several thousand amperes during the switch-on sequence. It also determine the rating of input devices such as switches, relays, fuses etc. To protect these input devices by limiting the peak of the inrush current we recommend the use of the active inrush current limitation circuit, option E.

Electrical Output Data

General Conditions:
– T_A = +25°C, unless T_C is specified
– With R control output voltage U_o = $U_{o\,nom}$ at $I_{o\,nom}$
– Sense lines connected at female connector

Table 3a: Output data

Output				PSS 5A12			PSK 5A16			PSK 5A20			PSK 5A25			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	5.07		5.13	5.07		5.13	5.07		5.13	5.07		5.13	V
I_o	Output current [1]		$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	0		12.0	0		16.0	0		20.0	0		25.0	A
I_{oL}	Output current limitation response			12.0		15.0	16.0		20.0	20.0		25.0	25.0		31.3	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		20	40		20	40		20	40		20	40	mV_{pp}
		Total			24	44		24	44		24	44		24	44	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min}...U_{i\,max}$, $I_{o\,nom}$		15	35		15	35		15	35		15	35	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0...I_{o\,nom}$		10	25		10	25		10	25		10	25	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		70			70			70			70		
t_d		Recovery time			40			40			40			40		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min}...T_{C\,max}$)		$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$			±1			±1			±1			±1	mV/K
						±0.02			±0.02			±0.02			±0.02	%/K

Table 3b: Output data

Output				PSS 1212			PSK 1216			PSK 1220			PSS 1212 [3]			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	11.93		12.07	11.93		12.07	11.93		12.07	14.91		15.09	V
I_o	Output current [1]		$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	0		12.0	0		16.0	0		20.0	0		12.0	A
I_{oL}	Output current limitation response			12.0		15.0	16.0		20.0	20.0		25.0	12.0		15.0	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		25	45		25	45		25	45		30	50	mV_{pp}
		Total			29	49		29	49		29	49		34	54	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min}...U_{i\,max}$, $I_{o\,nom}$		40	70		40	70		40	70		50	80	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0...I_{o\,nom}$		30	50		30	50		30	50		35	55	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		140			140			140			150		
t_d		Recovery time			60			60			60			60		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min}...T_{C\,max}$)		$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$			±3			±3			±3			±4	mV/K
						±0.02			±0.02			±0.02			±0.02	%/K

[1] See also *Thermal Considerations*.
[2] See *Technical Information: Measuring and Testing*.
[3] Output set to 15 V at R control input, see *Auxiliary Functions*.

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Table 3c: Output data

Output				PSK 1216 [3]			PSK 1220 [3]			PSS 2412			PSK 2416			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	14.91		15.09	14.91		15.09	23.86		24.14	23.86		24.14	V
I_o	Output current [1]		$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$	0		16.0	0		20.0	0		12.0	0		16.0	A
I_{oL}	Output current limitation response			16.0		20.0	20.0		25.0	12.0		15.0	16.0		20.0	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		30	50		30	50		30	60		30	60	mV_{pp}
		Total			34	54		34	54		34	64		34	64	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min} \ldots U_{i\,max}$, $I_{o\,nom}$		50	80		50	80		80	170		80	170	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0 \ldots I_{o\,nom}$		35	55		35	55		50	120		50	120	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		150			150			180			180		
t_d		Recovery time			60			60			60			60		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min} \ldots T_{C\,max}$)		$U_{i\,min} \ldots U_{i\,max}$ $I_o = 0 \ldots I_{o\,nom}$			±4			±4			±5			±5	mV/K
						±0.02			±0.02			±0.02			±0.02	%/K

Table 3d: Output data

Output				PSK 2420			PSS 3612			PSK 3616			PSK 3620			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	23.86		24.14	35.78		36.22	35.78		36.22	35.78		36.22	V
I_o	Output current [1]		$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$	0		20.0	0		12.0	0		16.0	0		20.0	A
I_{oL}	Output current limitation response			20.0		25.0	12.0		15.0	16.0		20.0	20.0		25.0	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		30	60		35	60		35	60		35	60	mV_{pp}
		Total			34	64		39	64		39	64		39	64	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min} \ldots U_{i\,max}$, $I_{o\,nom}$		80	170		120	250		120	250		120	250	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0 \ldots I_{o\,nom}$		50	120		60	200		60	200		60	200	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		180			200			200			200		
t_d		Recovery time			60			70			70			70		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min} \ldots T_{C\,max}$)		$U_{i\,min} \ldots U_{i\,max}$ $I_o = 0 \ldots I_{o\,nom}$			±5			±8			±8			±8	mV/K
						±0.02			±0.02			±0.02			±0.02	%/K

[1] See also *Thermal Considerations.*
[2] See *Technical Information: Measuring and Testing.*
[3] Output set to 15 V at R control input, see *Auxiliary Functions.*

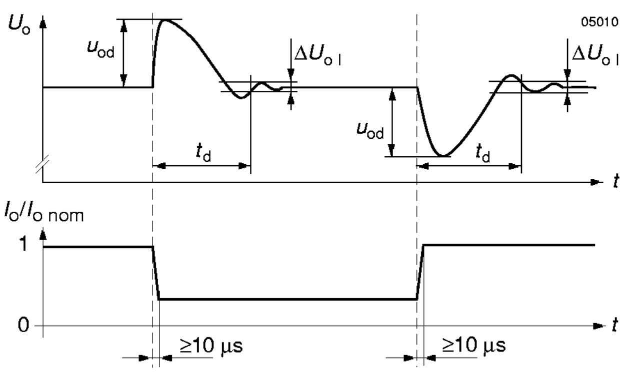


Fig. 2
Dynamic load regulation.

Overtemperature Protection

The unit is self-protecting by an internal temperature monitor, which inhibits the output above $T_{C\,max}$. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

Output Protection

A voltage suppressor diode which in worst case conditions fails into a short circuit, protects the output against an internally generated overvoltage. Such an overvoltage could occur due to a failure of either the control circuit or the switching transistor. The output protection is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Thermal Considerations

When a switching regulator is located in free, quasi-stationary air (convection cooling) at a temperature $T_A = 71$ °C and is operated at its nominal output current $I_{o\ nom}$, the case temperature T_C will be about 95°C after the warm-up phase, measured at the *Measuring point of case temperature* T_C (see *Mechanical Data*).

Under practical operating conditions, the ambient temperature T_A may exceed 71 °C, provided additional measures (heat sink, fan, etc.) are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C.

Example: Sufficient forced cooling allows $T_{A\ max} = 85$ °C. A simple check of the case temperature T_C ($T_C \leq 95$ °C) at full load ensures correct operation of the system.

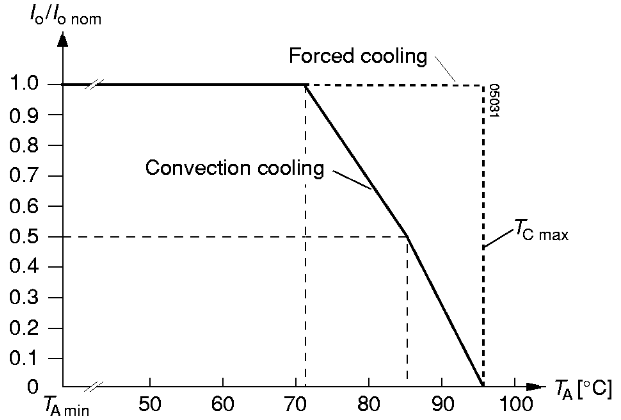


Fig. 3
Output current derating versus temperature.

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature (CS) for even distribution of the output current. See also *Auxiliary Functions.*

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Electrically separated source voltages are needed for each module!

Short Circuit Behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers – in contrary to the fold back method – automatically after removal of the overload or short circuit condition.

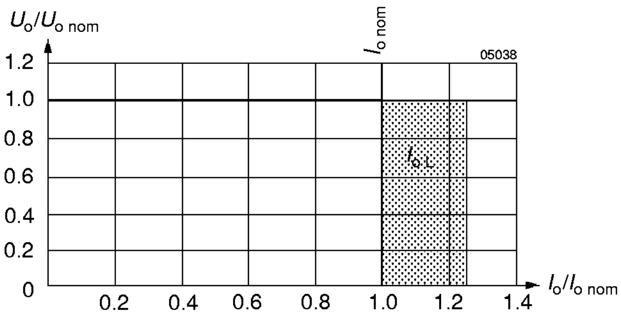


Fig. 4
Overload, short-circuit behaviour U_o versus I_o.

Auxiliary Functions

S Sense Lines

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector. See also *Technical Information.*

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\ max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the values given in the following table.

Table 4: Maximum allowed voltage compensation

Nominal output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
5.1 V	<0.5 V	<0.25 V
12, 15, 24, 36 V	<1.0 V	<0.25 V

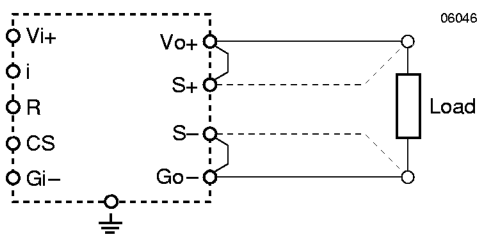


Fig. 5
Sense lines connection

i Inhibit for Remote On and Off

Note: With open i input, output is enabled (U_o = on)

The inhibit input allows the switching regulator output to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.). An output voltage overshoot will not occur when switching on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

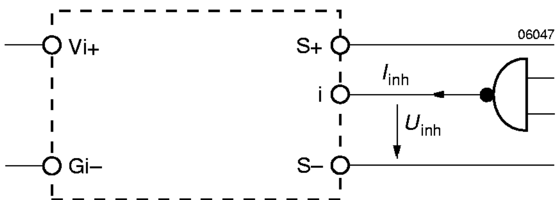


Fig. 7
Definition of I_{inh} and U_{inh}

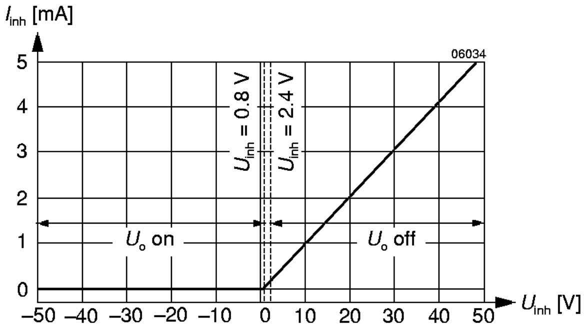


Fig. 6
Typical inhibit current I_{inh} versus inhibit voltage U_{inh}

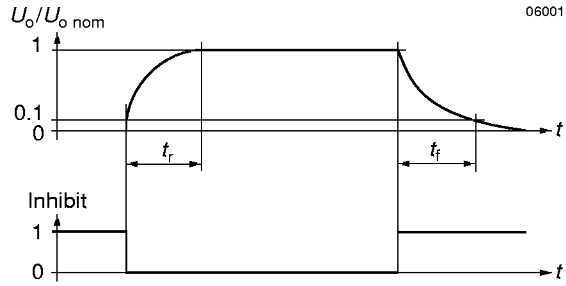


Fig. 8
Output response as a function of inhibit signal

Table 5: Inhibit characteristics

Characteristics			Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage to keep regulator output voltage...	U_o = on	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	–50		+0.8	V DC
		U_o = off		+2.4		+50	
t_r	Switch-on time after inhibit command		$U_i = U_{i\,nom}$ $R_L = U_{o\,nom} / I_{o\,nom}$		100		ms
t_f	Switch-off time after inhibit command				25		
$I_{i\,inh}$	Input current when inhibited		$U_i = U_{i\,nom}$		25		mA

R Control for Output Voltage Adjustment

Note: With open R input, $U_o \approx U_{o\,nom}$.

The output voltage U_o can either be adjusted with an external reference voltage (U_{ext}) or with an external resistor (R_1 or R_2). The adjustment range is $0...U_{o\,max}$. The minimum differential voltage $\Delta U_{io\,min}$ between input and output (see *Electrical Input Data*) should be maintained. Undervoltage lock-out = minimum input voltage.

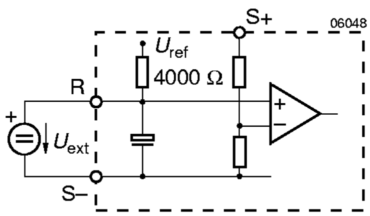


Fig. 9
Voltage adjustment with U_{ext} between R and S–

a) $U_o = 0...U_{o\,max}$, using U_{ext} between R and S–:

$$U_{ext} \approx 2.5\ \text{V} \cdot \frac{U_o}{U_{o\,nom}} \qquad U_o \approx U_{o\,nom} \cdot \frac{U_{ext}}{2.5\ \text{V}}$$

Caution: To prevent damage U_{ext} should not exceed 20 V, nor be negative and R_2 should never be less than 47 kW.

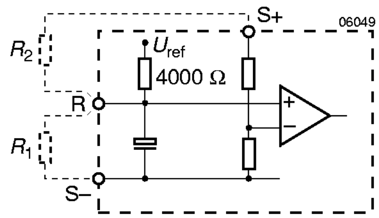


Fig. 10
Voltage adjustment with external resistor R_1 or R_2

b) $U_o = 0...100\%\ U_{o\,nom}$, using R_1 between R and S–:

$$R_1 \approx \frac{4000\ \Omega \cdot U_o}{U_{o\,nom} - U_o} \qquad U_o \approx \frac{U_{o\,nom} \cdot R_1}{R_1 + 4000\ \Omega}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 between R and S+:

$$R_2 \approx \frac{4000\ \Omega \cdot U_o \cdot (U_{o\,nom} - 2.5\ \text{V})}{2.5\ \text{V} \cdot (U_o - U_{o\,nom})}$$

$$U_o \approx \frac{U_{o\,nom} \cdot 2.5\ \text{V} \cdot R_2}{2.5\ \text{V} \cdot (R_2 + 4000\ \Omega) - U_{o\,nom} \cdot 4000\ \Omega}$$

Table 6: Maximum adjustable output voltage

Characteristics		Conditions	PSS 5A12 PSK 5A16 PSK 5A20 PSK 5A25			PSS 1212 PSK 1216 PSK 1220			PSS 2412 PSK 2416 PSK 2420			PSS 3612 PSK 3616 PSK 3620			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\,max}$	Maximum adjustable output at R control input	$U_{i\,nom}$, $I_{o\,nom}$	5.6			16.0			26.0			42.5			V

CS Current Sharing

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Test Sockets

Test sockets (pin ∅ = 2 mm) for measuring the output voltage U_o internally at the cxonnector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

LED Output Voltage Indicator

A green output indicator LED shines when the output voltage is higher than approx. 3 V.

Electromagnetic Compatibility (EMC)

Electromagnetic Immunity

General condition: Case not earthed.

Table 7: Immunity type tests

Phenomenon	Standard [1]	Class Level	Coupling mode [2]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form. [3]
1 MHz burst disturbance	IEC 60255-22-1	III	i/o, i/c, o/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	A
			+i/–i, +o/–o	1000 V_p					
Voltage surge	IEC 60571-1		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	B
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
Electrostatic discharge	IEC/EN 61000-4-2	4	contact discharge to case	8000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	A
Electromagnetic field	IEC/EN 61000-4-3	3	antenna	10 V/m	AM 80% 1 kHz		26…1000 MHz	yes	A
Electrical fast transient/burst	IEC/EN 61000-4-4	3	i/c, +i/–i	2000 V_p	bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period	50 Ω	1 min positive 1 min negative bursts per coupling mode	yes	A
		4		4000 V_p					B [4]
Surge	IEC/EN 61000-4-5	3	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. surges per coupling mode	yes	B
			+i/–i	1000 V_p		2 Ω			
Conducted disturbancies	IEC/EN 61000-4-6	3	i, o, signal wires	10 V_{rms} (140 dBµV)	AM 80% 1 kHz	150 Ω	0.15...80 MHz	yes	A

[1] For related and previous standards see *Technical Information: EMC*. [2] i = input, o = output, c = case.
[3] A = Normal operation, no deviation from specifications, B = Normal operation, temporary deviation from specs possible.
[4] With option C, manual reset might be necessary.

Electromagnetic Emission

For emission levels refer to *Electrical Input Data*.

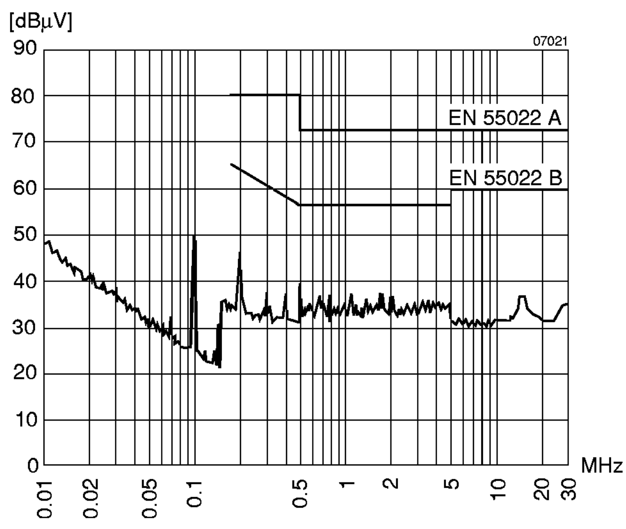


Fig. 11
Typical disturbance voltage (quasi-peak) at the input according to EN 55011/22 measured at $U_{i\,nom}$ and $I_{o\,nom}$.

Immunity to Environmental Conditions

Table 8: Mechanical stress

Test Method		Standard	Test Conditions		Status
Ca	Damp heat steady state	IEC/DIN IEC 60068-2-3 MIL-STD-810D, section 507.2	Temperature: Relative humidity: Duration:	$40^{\pm 2}$ °C $93^{+2/-3}$ % 56 days	Unit not operating
Ea	Shock (half-sinusoidal)	IEC/EN/DIN EN 60068-2-27 MIL-STD-810D, section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	100 g_n = 981 m/s^2 6 ms 18 (3 each direction)	Unit operating
Eb	Bump (half-sinusoidal)	IEC/EN/DIN EN 60068-2-29 MIL-STD-810D, section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	40 g_n = 392 m/s^2 6 ms 6000 (1000 each direction)	Unit operating
Fc	Vibration (sinusoidal)	IEC/EN/DIN EN 60068-2-6 MIL-STD-810D, section 514.3	Acceleration amplitude: Frequency (1 Oct/min): Test duration:	0.35 mm (10...60 Hz) 5 g_n = 49 m/s^2 (60...2000 Hz) 10...2000 Hz 7.5 h (2.5 h each axis)	Unit operating
Fda	Random vibration wide band Reproducibility high	IEC 60068-2-35 DIN 40046, part 23	Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration:	0.05 g^2/Hz 20...500 Hz 4.9 g_{rms} 3 h (1 h each axis)	Unit operating
Kb	Salt mist, cyclic (sodium chloride NaCl solution)	IEC/EN/DIN IEC 60068-2-52	Concentration: Duration: Storage: Storage duration: Number of cycles:	5% (30°C) 2 h per cycle 40°C, 93% rel. humidity 22 h per cycle 3	Unit not operating

Table 9: Temperature specifications, valid for an air pressure of 800...1200 hPa (800...1200 mbar)

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature [1]	Operational [2]	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature [1]	Non operational	–40	100	–55	100	

[1] MIL-STD-810D section 501.2 and 502.2.
[2] See *Thermal Considerations* and *Overtemperature Protection*.

Table 10: MTBF and device hours

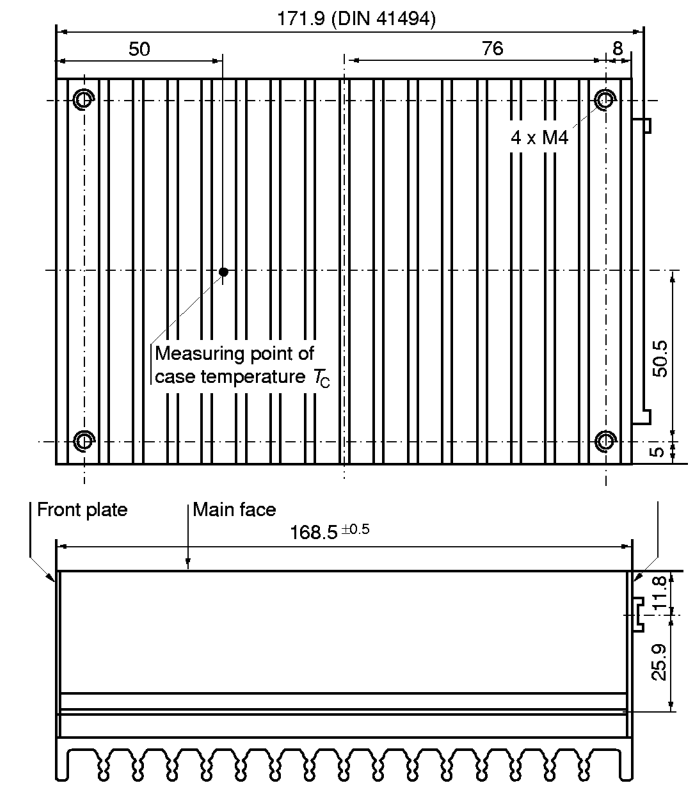
MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF acc. to MIL-HDBK-217F	T_C = 40°C	T_C = 40°C	T_C = 70°C	T_C = 50°C	
	335'000 h	138'000 h	35'000 h	33'000 h	2'100'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection



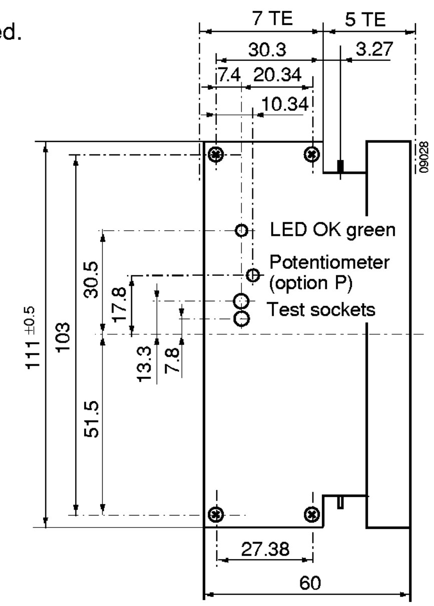
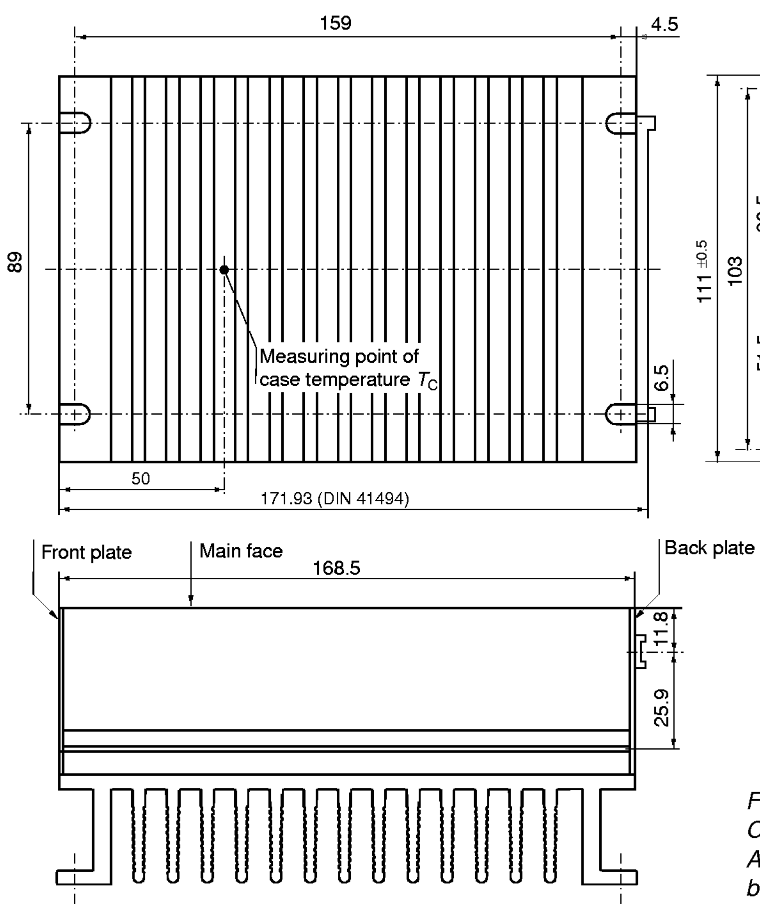
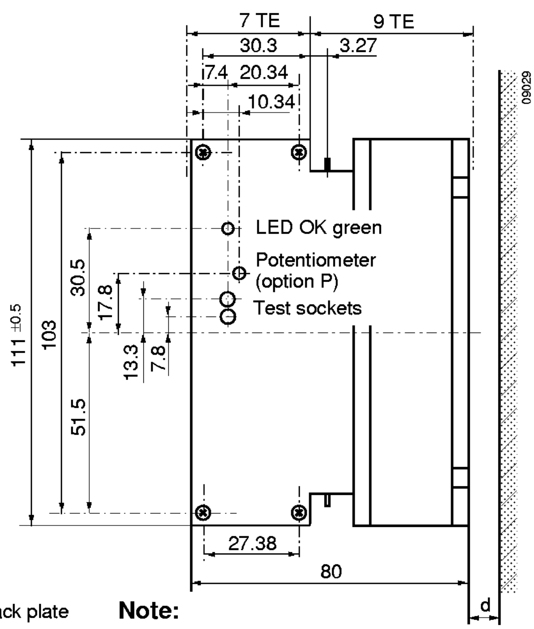


Fig. 12
Case S01, weight 1.3 kg
Aluminium, fully enclosed, black finish and self cooling.





Note:

- d ≥15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power.
- free air locations: the module should be mounted with fins in vertical position to achieve a maximum air flow through heat sink.

Fig. 13
Case K01, weight 1.6 kg
Aluminium, fully enclosed, black finish and self cooling.

Safety and Installation Instructions

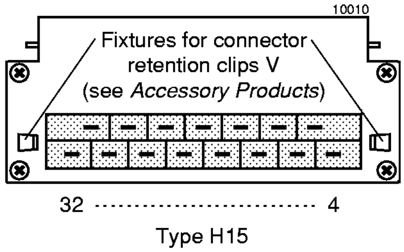
Connector Pin Allocation

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is leading, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 or H15 S4 (according to DIN 41612) to ensure requested safety!

Table 11: H15 and H15 S4 connector pin allocation

Electrical Determination	Type H15		Type H15 S4	
	Pin No.	Ident.	Pin No.	Ident.
Output voltage (positive)	4	Vo+	4/6	Vo+
Output voltage (positive)	6	Vo+		
Output voltage (negative)	8	Go–	8/10	Go–
Output voltage (negative)	10	Go–		
Crowbar trigger input (option C)	12	C	12	C
Inhibit input	14	i	14	i
R-input (output voltage programming) [1]	16	R	16	R
Sense line (negative)	18	S–	18	S–
Sense line (positive)	20	S+	20	S+
Current sharing control input	22	CS	22	CS
Protective ground (leading pin)	24	⏚	24	⏚
Input voltage (negative)	26	Gi–	26/28	Gi–
Input voltage (negative)	28	Gi–		
Input voltage (positive)	30	Vi+	30/32	Vi+
Input voltage (positive)	32	Vi+		

[1] Not available with option P



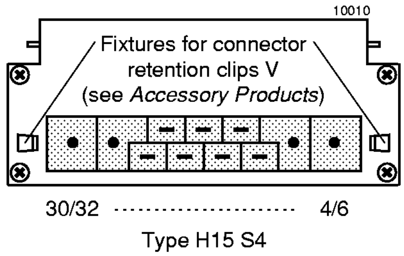


Fig. 14
View of male H15 and H15 S4 connector

Installation Instruction

Installation of the switching regulators must strictly follow the national safety regulations in compliance with the enclosure, mounting, creepage, clearance, casualty, markings and segregation requirements of the end-use application.

Check for hazardous voltages before altering any connections. Connections can be made using fast-on, screw or soldering technique, by means of female H15 connectors.

The input and the output circuit are not separated. i.e. the negative path is internally interconnected!

The units should be connected to a secondary circuit. Do not open any module. Ensure that a unit failure (e.g. by an internal short-circuit) does not result in a hazardous condition. See also *Safety of operator accessible output circuit.*

Note: Additional information on input circuitry, grounding and parallel operation of units is given in *Technical Information: Application Notes.*

Protection Degree

The protection degree is IP 30 (equipped with potentiometer adjustable option: IP 20). It applies only if the module is plugged-in or the female connector is properly attached to the module.

Isolation

Electric strength test voltage between input interconnected with output and case: 750 V DC, 1 s. This test is performed as factory test in accordance with IEC/EN 60950 and UL 1950 and should not be repeated in the field. Melcher will not honour any guarantee claims resulting from electric strength field tests.

Standards and Approvals

All switching regulators are UL recognized according to UL 1950, UL recognized for Canada to CAN/CSA C22.2 No. 234-M90 and SEV approved to IEC/EN 60950 and CISPR 14/EN 55014 standards.

The units have been evaluated for:

- Building in,
- Operational insulation from input to output and input/output to case,
- The use in a pollution degree 2 environment.
- Connecting the input to a secondary circuit which is subject to a maximum transient rating of 750 V.

The switching regulators are subject to manufacturing surveillance in accordance with the above mentioned UL and CSA and with ISO 9001 standards.

Safety of Operator Accessible Output Circuit

If the output circuit of a switching regulator is operator-accessible, it shall be an SELV circuit according to IEC/EN 60950 related safety standards.

The following table shows some possible installation configurations, compliance with which causes the output circuit of the switching regulator to be an SELV circuit according to IEC/EN 60950 up to a configured nominal output voltage of 30 V, or 48 V if option C is fitted.

However, it is the sole responsibility of the installer or user to assure the compliance with the relevant and applicable safety regulations.

More information is given in *Technical Information: Safety.*

Table 12: Insulation concept leading to an SELV output circuit

Conditions	Front end			Switching regulator	Result
Supply voltage	Minimum required grade of isolation, to be provided by the AC-DC front end, including mains supplied battery charger	Maximum DC output voltage from the front end [1]	Minimum required safety status of the front end output circuit	Measures to achieve the specified safety status of the output circuit	Safety status of the switching regulator output circuit
Battery supply, considered as secondary circuit	Double or Reinforced	≤60 V	SELV circuit	None	SELV circuit
		>60 V	Earthed hazardous voltage secondary circuit [2]	Input fuse [3] and earthed [4] or non accessible case [5]	Earthed SELV circuit
			Unearthed hazardous voltage secondary circuit [5]	Input fuse [3] and unearthed, non accessible case [5]	Unearthed SELV circuit
			Hazardous voltage secondary circuit	Input fuse [3] and earthed output circuit [4] and earthed [4] or non accessible case [5]	Earthed SELV circuit
Mains ≤250 V AC	Basic	≤60 V	Earthed SELV circuit [4]	None	
			ELV circuit	Input fuse [3] and earthed output circuit [4] and earthed [4] or non user accessible case [5]	
		>60 V	Hazardous voltage secondary circuit		
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		>60 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [5]	Input fuse [3] and unearthed and non accessible case [5]	Unearthed SELV circuit

[1] The front end output voltage should match the specified input voltage range of the switching regulator.
[2] The conductor to the Gi– terminal of the switching regulator has to be connected to earth by the installer according to the relevant safety standard, e.g. IEC/EN 60950.
[3] The installer shall provide an approved fuse (slow blow type with the lowest current rating suitable for the application, max. 12.5 A) in a non-earthed input conductor directly at the input of the switching regulator. If Vo+ is earthed, insert the fuse in the Gi- line. For UL's purpose, the fuse needs to be UL-listed.
[4] The earth connection has to be provided by the installer according to the relevant safety standard, e.g. IEC/EN 60950.
[5] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum output voltage from the front end.

5

Description of Options

-9 Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A = -40...71\,°C$.

P Potentiometer

Note: Option P is not recommended if several modules are operated in parallel connection.

Option P excludes R function. The output voltage U_o can be adjusted with a screwdriver in the range from 0.9...1.1 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in *Electrical Input Data* should be maintained.

E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i/1\,\Omega$ and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

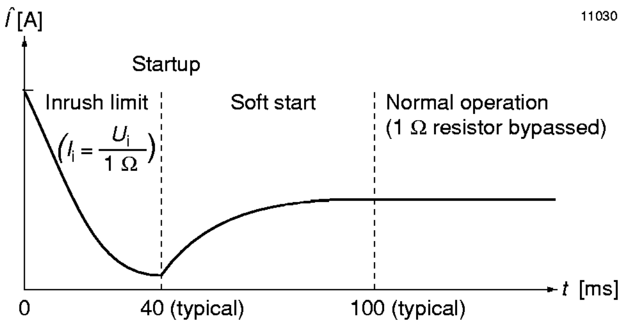


Fig. 15
Option E: Inrush current versus time

C Thyristor Crowbar

Note: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage U_o and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

5

Table 13: Crowbar trigger levels

Characteristics		Condition	PSS 5A12 PSK 5A16 PSK 5A20 PSK 5A25			PSS 1212 PSK 1216 PSK 1220			PSS 2412 PSK 2416 PSK 2420			PSS 3612 PSK 3616 PSK 3620			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\,C}$	Trigger voltage	$T_{C\,min}...T_{C\,max}$ $U_{i\,min}...U_{i\,max}$		6.3	6.7		17.8 14.3	18.9 15.2 [1]		28.89	30.6		47.0 43.0	50.0 45.5 [1]	V DC
t_s	Delay time	$I_o = 0...I_{o\,nom}$		1.5			1.5			1.5			1.5		µs

[1] Crowbar Trigger voltage with option P

B, B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

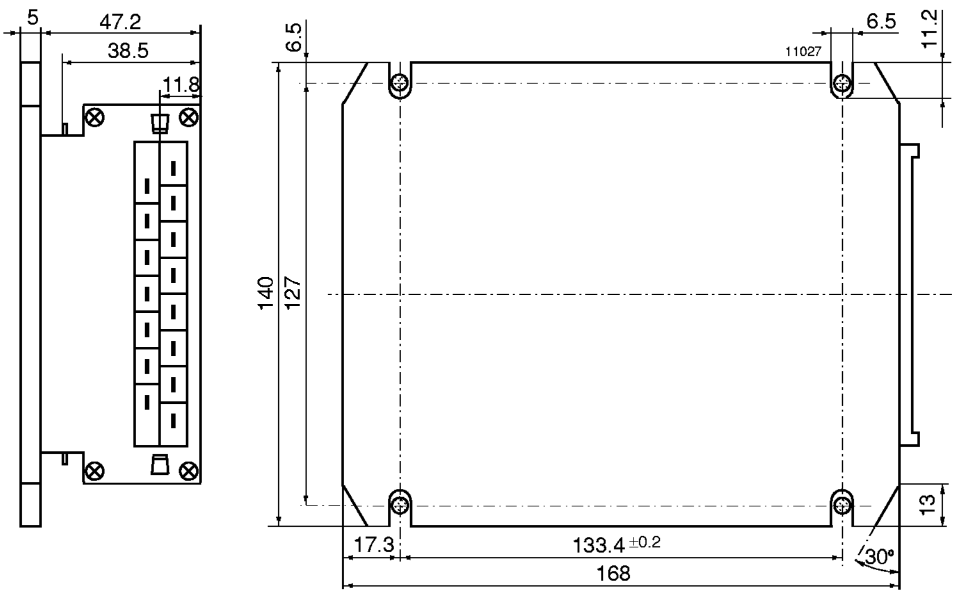


Fig. 16
Option B, large cooling plate
Weight: 1.2 kg

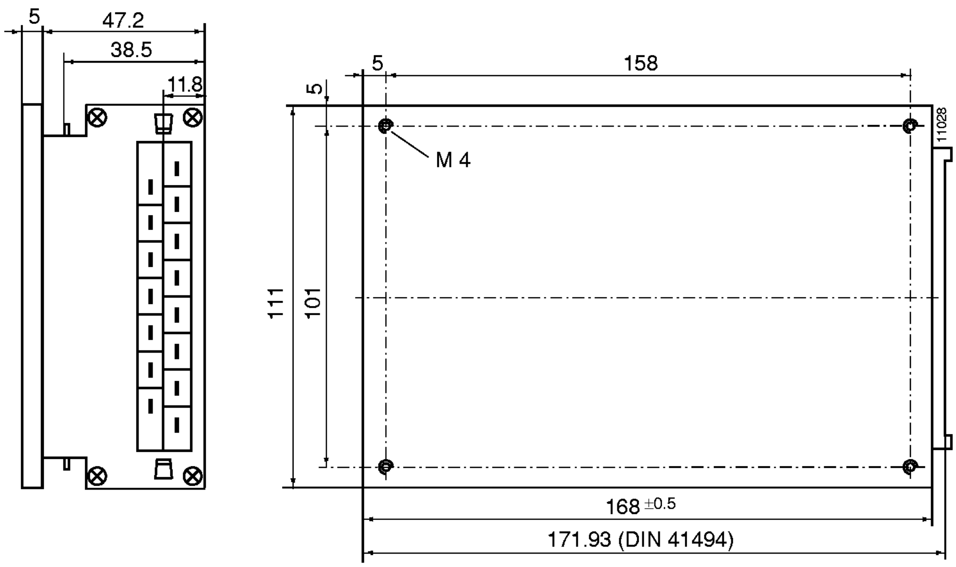


Fig. 17
Option B1, small cooling plate
Weight: 1.2 kg

Accessories

A variety of electrical and mechanical accessories are available including:

– Front panels for 19" rack mounting, Schroff and Intermas systems, 12 and 16 TE.
– Mating H15 and H15 S4 connectors with screw, solder fast-on or press-fit terminals.
– Connector retention facilities.
– DIN-rail mounting adaptor.

For more detailed information please refer to *Accessory Products.*